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(54) Title: CELLULOSIC FIBRE-POLYMER COMPOSITE

(57) Abstract: The invention provides a cellulosic fibre-composite material comprising: (a) a plastics material (i) and (b) a mixture of a fibrous cellulosic material (ii), and glass reinforced plastics material (iii). The glass reinforced plastics (GRP) material (iii) is preferably waste glass reinforced plastics material. The material may comprise a thermoset plastics material reinforced with glass fibres. Methods of recycling items made of GRP, and making composites using GRP waste are also provided, as are products obtainable by such methods or comprising such composite materials.



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## CELLULOSIC FIBRE-POLYMER COMPOSITE

The invention relates to cellulose fibre-polymer composite material comprising plastics material and a mixture of fibrous cellulosic material and glass reinforced plastics material. Methods of producing such composites, for example from recycled material, such as recycled glass reinforced plastic, are also provided.

Conventional structural manufacture, for example of windows and doors or building furniture such as skirting board, has used vinyl, wood and metal components for forming the structural members. Wood has been used for many hundreds of years and has been shaped into structural components. Wooden structure, whilst structurally strong, can suffer problems under certain circumstances related to the deterioration of the wood components. Wood windows also suffer from cost problems related to the availability for suitable wood for construction.

Further, plastic polyvinyl chloride (PVC) has been combined with wood members, or used instead of wood members, for many years. A problem with plastic materials has been that the plastic materials, such as PVC, often do not have sufficient strength, thermal expansion, elasticity or workability properties to allow them to be successfully used. Furthermore, plastics and wood products have conventionally been expensive.

There is therefore a need to provide a cheaper product. Efforts were therefore made to combine wood by-product materials, such as sawdust, with recycled thermoplastic products, such as recycled PVC. Conventionally, these materials had been burned for their heat value and electrical power generation or were shipped to landfill sites for disposal.

It is known that it is possible to form a replacement for a wood structural member by forming structural members from a polymer and a wood fibre composite material. For example, US 5,406,768 discloses combining PVC with wood sawdust material in a typical concentration of 60 wt.% PVC with 40 wt.% sawdust. This material is extruded or injection moulded into a linear member with a hollow profile.

The wood fibre normally used by manufacturers of fibre-plastic composites is finely powdered to a substantially flour-like consistency. This is because those manufacturers have conventionally thought that finely powdered wood fibre produces a "better" finish on the fibre-plastic composites. Furthermore, the use of sawdust, and especially finely powdered sawdust that has been milled to produce a fine flour-like consistency, is potentially dangerous because of the risk of powder-explosions should a spark be allowed to ignite the wood-powder. This has meant that the wood fibre is often pre-pelletised, either cellularly or in combination with the plastics material and stored, prior to being used in either injection moulding or extrusion processes to create pellets which have reduced fallibility. Conventionally the wood fibre is milled to a flour-like consistency, dried in a kiln, mixed with plastics material and then extruded and cut to pellets. Typically, the pellets are cylindrical with a radius of 1-5 mm. and a length of 1-10 mm.

WO 2005/025827 provides methods of producing fibre-plastic (WPC) composites using fibrous cellulosic material and plastic material. Products produced by the disclosed methods are suggested as being useful for the production of doorframes, window frames and stair cases. The document suggests using recycled thermoplastic material and wood or other cellulosic material waste. Glass-reinforced plastic (GRP) is mentioned in combination with an external co-extruded plastic layer, without wood waste. This co-extruded GRP layer is used to strengthen the fibre-plastic composite product.

US 5,516,472 discloses the production of wood-fibre composites using recycled wood scraps, such as wood flakes, wood chips, sawdust and newspaper. A variety of different based thermoplastic materials are referred to, but not glass-reinforced plastic.

US 5,474,722 discloses using fibre or flakes to reinforce thermoplastic composite materials. Wood fibres are orientated during the extrusion process to improve the strength of the material. A number of alternative oriented reinforcing fibres, which are added to the plastic as conventional strengthening material, is disclosed, including glass fibres, asbestos, mica, talc, wollastonite and wood fibres. A number of alternative sources of cellulosic material, including drinks containers comprising laminates of aluminium foil, cardboard and plastic, are indicated as possibly being used.

US 5,406,768 is another patent which discloses wood-plastic composites. The document indicates that the sawdust material used within the composite can contain substantial proportions of a by-product stream, including PVC and other polymeric materials that have been used in coating, cladding or envelope of wood members, thermoplastic materials, polymeric materials from coatings, adhesives, paints and other streams common with the manufacture of wooden doors and windows.

Composite doors comprising a framework of, for example, wood, are known in the art. The framework is typically sandwiched between two skins comprising glass reinforced plastic. The glass reinforced plastic provides a substantially weatherproof and durable finish to the door. Between the glass reinforced plastic skins, in the voids between the skin and the framework, is often provided polyurethane foam which acts as insulating material for both heat and sound. A problem associated with this form of composite door is that parts of the glass reinforced plastic skin are often cut away to allow the insertion of, for example, windows or letterboxes. This produces a considerable amount of glass reinforced plastic waste and which may additionally contain polyurethane foam. Such material does not readily decompose, cannot be readily incinerated, and hitherto has had to be put in landfill at considerable financial cost to the door manufacturer, and environmental cost to the area surrounding the landfill site. However, it was not expected that such material could be recycled as it usually contains non-recyclable thermoset resins.

The inventors have unexpectedly realised that it may be possible to incorporate the glass reinforced plastic waste into wood-plastic composite materials. Furthermore, they can do this whilst not substantially affecting the structural properties of the material.

Glass reinforced plastic (GRP) typically contains glass fibres surrounded by a solid matrix. The solid matrix is usually a thermoset material such as a polyester resin. That is, heating the GRP does not normally result in the softening and melting of the plastics matrix surrounding the glass fibres. Hence, it was not expected that the GRP could be used as a substitute for, for example, recycled plastic used to produce the wood-plastic composite material. Indeed, it was not known whether it would be possible to produce wood-plastic composites containing GRP, without significant loss of structural strength of the finally produced composite.

The inventors have unexpectedly found that it is possible to substitute some of the fibrous cellulosic material with waste glass reinforced plastics material.

The invention therefore provides: a cellulosic fibre-polymer composite material comprising:

- (a) plastics material (i); and
- (b) a mixture of fibrous cellulosic material (ii), and glass reinforced plastics material (iii).

Preferably the composite material is for use as a structural material. That is, it is preferably for use as a portion of a window, doorframe, door, staircase, fencing, decking or cladding.

The glass reinforced plastics material (GRP) comprises glass fibres within a solidified matrix of plastics material.

GRP, which is also known as fibreglass reinforced plastic, is typically made from molten glass which has been extruded. The fibres are gathered into bundles and the bundles combined to create a roving. The glass fibres are typically made from rovings that are either chopped into short strands or woven into cloth. When GRP is made the glass fibres are typically placed into a plastic matrix. Thermoplastic material, such as polyethylene (PE), polyvinyl chloride (PVC) and polypropylene (PP) is rarely used as the polymer matrix. More conventionally, GRP utilises a thermoset plastic. Hence, preferably the GRP is a thermoset GRP utilising a thermoset plastic. Thermoset plastics are those in which the polymer molecules are cross-linked with another set of molecules to form a "net-like" or "ladder-like" structure. Once cross-linking has occurred, a thermoset plastic does not usually soften, melt or flow when heated. The thermoset plastic may be a polyamide, polyester (for example an unsaturated polyester resin), vinyl ester, acrylic, maleic, an epoxy, or a phenolic plastics or other thermoset plastics, such as melamine formaldehyde.

Most preferably, the GRP is recycled GRP. That is, it has been recovered from a previous use. The GRP is preferably broken down into particulate material, prior to mixing with the fibrous cellulosic material and plastics material.

Preferably, the size of the glass reinforced plastic particles are less than 10 mm, especially less than, or equal to 5 mm, less than 4 mm, less than 3 mm, less than 2 mm or less than 1

mm in size. Preferably, the size of the particulate material is identified by taking the particulate material and passing it through, for example, a mesh having a diameter of 10 mm to remove particles having a diameter of greater than 10 mm. More preferably, the mesh screen is less than 5 mm, less than 4 mm, less than 3 mm, less than 2 mm, more preferably less than 1 mm in diameter. Metallic contaminants may be removed, for example, by the mesh screen or by use of a magnet.

Preferably, no further screen of the size of a material is used. A further screen to remove particles of less than 0.5 mm or 0.1 mm is preferably not used. That is, preferably the material contains particles which range in size from fine dust-like particles to particles having a diameter which just allows them to pass through the screen. These larger particles may have longer lengths than the diameter of the screen, for example they may have a 1 mm diameter to pass through a 1 mm diameter screen, but still have a length of 3-5 mm.

The size of the particles may be obtained by pulverising waste GRP through a suitable pulveriser, prior to screening through, for example, a mesh.

The GRP used preferably contains between 5 and 50% by weight of glass fibre, more typically 20-40, especially approximately 30% by weight of glass fibre. The remainder of the weight of the GRP may be filler, such as calcium carbonate, aluminium trihydrate, feldspar or calcium sulphate. At least a part of the remaining portion of the GRP will also be the plastics matrix. Additionally, there may be, for example, pigments, remains of catalysts, such as benzoyl peroxide, which are added to thermoplastic resins to cause them to set faster, paints, ABS (acrylonitrile butadiene styrene) and fire retardants. Additionally, the glass reinforced plastics material may comprise polyurethane foam. Thermoplastic or thermoset urethane foams are typically used as insulating material between, for example, GRP skins on composite doors. The inventors have found that it is possible to simply retain the polyurethane foam and break the foam down as part of the total weight of GRP added to the cellulosic fibre-polymer composite material.

Preferably, the glass fibres when mixed in the final composite product are oriented substantially randomly. That is, they are simply mixed within the composition and are not oriented, for example along an axis.

Preferably, the fibrous cellulosic material is sawdust from soft- or hardwood. However, cellulosic material may be obtained from, for example, recycled cloth, cotton waste, straw from, for example, barley or maize, seed husks and nuts, hemp, jute, rice and sugarcane waste, or recycled paper. The concentrations of the fibrous cellulosic material may vary from source to source, as different sources of fibrous cellulosic material have different properties. For example, softwoods contain a high concentration of lignins, but lower concentrations of hemicellulose than hardwoods. By cellulosic material, we mean a material that contains a cellulose polymer or a derivative of a cellulose polymer such as hemicellulose.

The plastics material may be in the form of a virgin plastics material, that is one that has not been used for other purposes before. This virgin plastic may be as a polymeric form or be in the form of monomers. Monomers are especially used where the plastics material is a thermosetting polymer. Thermoplastic materials, such as polyethylene, PVC and polystyrene are materials that can be softened by heating and then which harden again on cooling. However, thermosetting materials which first soften on heating and then with further heating set hard and there afterwards cannot be softened again by heat may also be used.

Most preferably, the plastics material is waste plastics material. That is, the material has been used for other purposes and then recycled. This plastics material may be chipped, prior to mixing with the fibrous cellulosic material. Waste material may be also comprise one or more contaminants, such as paints, waxes, stearate, foaming agents, bulking agents, titanium dioxide, stabilisers, master batch, colorants, talcs, surfactants and/or preservatives.

Preferably, the plastics material is selected from a polyolefin, uPVC, polypropylene, polyethylene, polyamide, poly(meth)acrylates, acrylonitrile-butadiene-styrene (ABS), polystyrene, polyphenylene oxides, polyhydroxy- butyrate (PHB), polyhydroxyvalerate, or copolymers or mixtures thereof, or monomers of the polymers.

A combination of uPVC and polyethylene is particularly preferred.

Polyhydroxybutrate (PHB) and co-polymers with polyhydroxyvalerate are especially preferred. Such polymers are so-called "biopolymers". They have been produced for a number of years by means of microbial and plant systems which have been engineered to produce the polymers. Therefore, these polymers are perceived to be environmentally friendly, thus improving the marketability of the product.

The mixture of the fibrous cellulosic material and plastics material may comprise one or more of waxes, stearate, foaming agents, bulking agents, titanium dioxide, stabilisers, master batch, colorants, talcs, surfactants and/or preservatives. Preferably, less than 10%, less than 5%, especially less than or equal to 2% of the total amount of the mixture of cellulosic material, plastics material and GRP, with the additives, by weight, is such additive material.

Preferably, 100% of the plastics material is recycled. However, preferably less than 50%, less than 40%, less than 30%, less than 10% by weight of the plastics material used in the method or mixture is virgin plastics material. This virgin plastics material may be incorporated to improve the structural properties of the plastic-fibre composite, although in practice the Applicants have found that this is not normally required.

Mixtures of different plastics materials and/or mixtures of fibrous cellulosic materials may be used.

Preferably, the composite material comprises:

- (a) less than 50% by weight of plastics material (i); and
- (b) more than 50% by weight of the mixture of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii),

where the total of (a) and (b) adds up to 100%.

Most preferably, the composite material contains less than 40%, less than 35%, less than 30%, less than 25%, especially less than 20% by weight of plastics material. Preferably, the composite contains at least 5%, most preferably at least 10% by weight of plastics material.



The fibrous cellulosic material may be provided by taking the raw material and passing it through a 5 mm diameter mesh screen to remove particles having a diameter of less than 5 mm. More preferably, the mesh screen is less than 4 mm, less than 3 mm, less than 2 mm, more preferably 1 mm in diameter. Metal contaminants are preferably removed from the fibrous cellulosic material, for example by the mesh screen or by use of a magnet.

Preferably, the glass reinforced plastics material (iii) is up to 30% by weight of total weight of the mixture (b) of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii).

More preferably, the amount of GRP is between 1% and 25%, especially less than 20%, or less than 15%, most preferably between 5 and 10% by weight of the mixture (b) of fibrous cellulosic material and the glass-reinforced plastics material (iii).

Preferably, the glass reinforced plastics material (iii) comprises 5%-50%, most preferably 10-40%, more preferably 20-30% of glass fibre by weight.

Methods of producing a cellulosic fibre-composite product are also provided. A further aspect of the invention provides a method of producing a cellulosic fibre-polymer composite product comprising:

(A) Mixing a portion (a) of plastics material with (b) a mixture of particulate cellulosic material (ii) and a particulate glass reinforced plastics material (iii);

(B) Causing the mixture of plastics material, particulate cellulosic material and glass-reinforced plastics material to solidify to form a cellulosic fibre-polymer composite product.

Preferably, the particulate cellulosic material is made by recycling an item made of a glass reinforced plastics material and breaking the glass reinforced plastics material into particles. Hence, a further aspect of the invention provides a method of recycling an item made of a glass reinforced plastics material comprising breaking the glass reinforced plastics material (iii) into particles, mixing the particles with fibrous cellulosic material (ii) to form a mixture (b); adding a portion (a) plastics material (i); and causing the plastics material (i), fibrous cellulosic material (ii) and glass reinforced plastics material (iii) to solidify to form a cellulosic fibre polymer composite product.

Preferably, the item is at least a part of a door, electrical junction box or glass reinforced boat. Electrical junction boxes, for example, which are used to cover telephone junction boxes, fibre optic cable boxes or satellite television cable boxes are found on many streets in western Europe and the United States. These are typically made of fibreglass. Hence, the fibreglass material, when the junction box is disposed of, is usually disposed of in a landfill site. The method of the invention allows the glass reinforced fibre material to be recycled into other items. Similarly, glass reinforced boats are usually dumped in landfill sites. The technique allows the glass reinforced boat to be recycled.

A still further aspect of the invention provides a method of making the cellulosic fibre composite comprising:

- (A) Providing a door, the door comprising one or more panels, at least one of said panels comprising a glass reinforced plastics material;
- (B) Cutting out one or more cut outs from said panels to produce cut out waste comprising glass reinforced plastics material;
- (C) Breaking the cut out waste into particulate glass reinforced plastics material (iii);
- (D) Mixing the particulate glass reinforced plastics material (iii) with particulate cellulosic material (ii) to form a mixture (b);
- (E) Mixing the mixture (b) with a portion (a) of plastics material; and
- (F) Causing the plastics material (i), fibrous cellulosic material (ii) and glass-reinforced plastics material (iii) to solidify to form a cellulosic fibre-polymer composite product.

Preferably the door comprises a frame, such as a wood or WPC frame, sandwiched between two or more panels.

Preferably, the door cut outs are obtained when one or more panels are removed from the door to allow the insertion of windows, or alternatively the insertion of door furniture such as letterboxes or door handles.

Solidification of the product may be achieved, for example, using a thermoset resin or by heating and cooling if a thermoplastic plastic material is used.

Preferably, the plastics materials, particulate cellulosic materials and glass-reinforced plastic materials used in any of the methods of the invention are as defined above for the first aspect of the invention, and preferably used in the ratios under the conditions defined for the first aspect of the invention.

Preferably, the mixture of (a) plastics material (i) and (b) particulate cellulosic material (ii) and glass-reinforced plastics material (iii) is heated, extruded through a die and then cooled to form an extruded product.

The extrusion of cellulosic fibre-polymer composites *per se* is itself known in the art, as indeed discussed in WO 2005/025827, US 5,516,472, GB 1,443,194, US 6,117,924 and US 5,406,768.

Preferably, the plastics material, particulate cellulosic material and the glass-reinforced plastics material are all recycled materials.

The invention also provides cellulosic fibre-polymer composite products comprising a composite material according to the first aspect of the invention or obtainable by one of the methods of the invention. The product may be a portion of a window, doorframe, door, staircase, decking, fencing or cladding.

Preferably, the product is a rail, jamb, sill, track, stop sash or a trim element such as a skirting board, grid, cove or quarter ran, or at least a portion of a door frame.

The inventors have found that such products can be made without substantially decreasing the structural properties of the material, whilst still allowing the incorporation of GRP.

The invention also provides a method of making a door comprising providing at least a portion of the doorframe product obtained by a method according to the invention or made from a composite product according to the invention and sandwiching the doorframe between at least two panels, at least one of said panels comprising a glass-reinforced plastic material. This allows, for example, cut outs from previous doors comprising a GRP skin to be mixed with plastics material and fibrous cellulosic material to produce frames for the door and to be incorporated into new doors.

Indeed, the inventors have also found that it is possible to recycle the entire door. The invention provides a method of recycling a door, the door comprising a frame sandwiched between two or more panels, at least one of said panels comprising glass reinforced plastics material, said method comprising the steps of:

- (A) Breaking the door, including the frame and panels, into particulate glass reinforced plastics material (iii);
- (B) Mixing the particulate glass reinforced plastics material (iii) with particulate cellulosic material (ii) to form a mixture (b);
- (C) Mixing the mixture (b) with a portion (a) of plastics material; and
- (D) Causing the plastics material (i), fibrous cellulosic material (ii) and glass-reinforced plastics material (iii) to solidify to form a cellulosic fibre-polymer composite product.

Preferably, metallic material, such as door handles, letterboxes and hinges, and where appropriate glass windows, are removed prior to breaking the door into particulate glass reinforced plastics material.

It has been found to be possible to mix such material in amounts of approximately 1:1 weight to weight with the particulate fibre cellulosic material.

The invention will now be described by way of example only with reference to the following figures:

Figure 1 shows a schematic view of a cross-section through a door.

Figure 2 shows a schematic view of a door indicating the positions of typical cut-out portions.

Figure 3 shows a schematic view of an extruder for use with the invention, from one side (Figure 3a), and above (Figure 3b).

Figure 1 shows a cross-section through a door (10) comprising a frame (12). The frame is conventionally made of wood, but may also be made of a cellulosic fibre-plastic composite material according to the invention. Alternatively, a conventional wood-plastic composite material may also be used. A frame (12) is sandwiched between a front skin of a glass reinforced plastics material (14) and a rear skin of glass reinforced plastics material (16). The glass reinforced plastics material skin (GRP) may be used made of any GRP known in the art for this purpose. Typically, the GRP uses a thermoset plastic for the plastics matrix surrounding the glass reinforcing fibres. Typically, polyester is used as the thermoset plastic. The void between the skins (14, 16) and frame (12) may be left empty. Alternatively, the void (18) is typically filled with a foam, such as a polyurethane foam.

Conventionally, doors of this sort are made in one piece with a whole front skin (14) and rear skin (16). Figure 2 indicates that when it is desired to insert glass into the door, or alternatively add an opening for a letterbox, then the areas indicated as (20) for a letterbox or alternatively panels (22) may be removed to allow the insertion of suitable door furniture or glass. It is the cut-outs (20, 22) that hitherto have been left to put into landfill sites. The cut-outs may be simply GRP that has been cut out from the door (10). The GRP may additionally contain polyurethane foam from within the cavity (18).

The inventors have found that all of this material may be added to cellulosic material and used to make cellulosic-polymer composites. The waste GRP material is typically broken down in a grinder. The material may be sieved using, for example, a 10 mm or 5 mm mesh to remove larger particles of the GRP. The GRP typically includes fragments of polyurethane foam, paint, pigments, ABS and fillers such as calcium carbonate used with the GRP.

The inventors have found that this may be mixed with, for example, waste sawdust in an amount of up to 30% by weight of the total of the mixture of fibre cellulosic material and glass reinforced plastics material without significantly affecting the durability or scope of the final cellulosic fibre-polymer composite material. The mixture of fibre cellulosic material and glass-reinforced plastics material is typically added in an amount of at least 50% by weight of the mixture in combination with less than 50% by weight of a plastics material. The plastics material is preferably waste material such as PVC or other thermoplastics material. Alternatively, the plastics material may itself be a thermosetting resin, although this is not usually used as it is most preferable to use recycled plastics material.

Figure 3 shows a schematic diagram of a typical extruder (30) used by the inventors, from a side (Figure 3a) and above (Figure 3b).

GRP, such as waste from door cut-outs, fibrous cellulosic material, such as sawdust, and plastics material, is mixed together. Typically, the plastics material is recycled PVC. The GRP and sawdust is typically sieved to particle sizes of below 10 mm by using a mesh. The plastics material is usually provided as pellets or as fragmented, sieved material.

The mixed material is added to the extruder (30) via a hopper (32). The extruder may be any suitable extruder known in the art. Extruders are made by a number of manufacturers, including Cincinnati Extrusion GmbH, Vienna, Austria. The extruder used was a Cincinnati Titan wood extruder.

The exemplified arrangement shown schematically in Figure 3 uses a pair of heated counter-rotating screws (34) that heat up, compress, and force the mixture towards an outlet (36). The preferred device comprises one or more vacuum vents (38) for removal of moisture released by the material. This is preferable since the waste materials used may have become damp during storage or transportation to the factory where extrusion takes place.

Provided mounted on the outlet may be any suitable die to mould the extruded product. Such dies are themselves well known in the art for the formation of extrusions from thermoplastic materials. Such extrusions may be for use in door frames, decking and fencing, cladding, window frames and garden furniture. Examples include those described in, for example, GB 1,443,194, US 5,516,472 and US 5,406,768.

The temperature, pressures and extrusion speeds may be varied depending on the polymer used and content. Typical temperatures for PVC containing material on entering the die, was usually less than 200°C and typically between 150°C and 170°C. Pressures of up to 200 bar were used. The extrusion is cooled on leaving the die to produce a solidified extrusion.

The inventors found that, using such extrusion systems, it is possible to replace some of the wood content in the wood-plastic composite by waste glass reinforced plastic without substantially affecting the strength of the product.

Wood/PVC mixtures were tested typically with between 50% and 70% by weight wood and, where present, GRP waste. When waste from door cut-outs is used, then up to 30% of the wood content may be replaced by the GRP waste. If above 30% of the wood component is replaced by GRP a significant loss of strength of the product was observed. 5% replacement was observed to maintain high structural strength, with 7.5 to 10% by weight of wood waste replaced by GRP still observed to have good structural strength. Physical strength was measured, for example, by the ability to resist a weight placed on the material without the material fracturing.

### Claims

1. A cellulosic fibre-polymer composite material comprising:
  - (a) plastics material (i); and
  - (b) a mixture of fibrous cellulosic material (ii), and glass reinforced plastics material (iii).
2. A composite material according to claim 1, wherein the glass-reinforced plastic material (iii) is waste glass-reinforced plastic material.
3. A composite material according to claim 1 or claim 2, wherein the glass-reinforced plastics material comprises a thermoset plastics material reinforced with glass fibres.
4. A composite material, according to any preceding claim, comprising:
  - (a) less than 50% by weight of plastics material (i); and
  - (b) more than 50% by weight of the mixture of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii),where the total of (a) and (b) adds up to 100%.
5. A composite material according to claim 4, wherein the glass reinforced plastics material (iii) is up to 30% by weight of the total weight of the mixture (b) of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii).
6. A composite material according to any preceding claim wherein the glass reinforced plastics material comprises 5% to 50% by weight of glass fibre.
7. A composite material according to any one of the preceding claims wherein the glass reinforced plastics material comprises one of more components selected from: polyurethane foam, fillers, paint, pigments, ABS and fire retardants.
8. A method of producing a cellulosic fibre-polymer composite product comprising:



(A) Mixing a portion (a) of plastics material with (b) a mixture of particulate cellulosic material (ii) and a particulate glass reinforced plastics material (iii);

(B) Causing the mixture of plastics material, particulate cellulosic material and glass-reinforced plastics material to solidify to form a cellulosic fibre-polymer composite product.

9. A method of recycling an item made of a glass reinforced plastics material comprising breaking the glass reinforced plastics material (iii) into particles, mixing the particles with fibrous cellulosic material (ii) to form a mixture (b); adding a portion (a) of plastics material (i); and causing the plastics material (i), fibrous cellulosic material (ii) and glass reinforced plastics material (iii) to solidify to form a cellulosic fibre polymer composite product.

10. A method according to claim 9, wherein the item is at least a part of a door, electrical junction box or glass reinforced boat.

11. A method of making the cellulosic fibre composite comprising:

(A) Providing a door, the door comprising one or more panels, at least one of said panels comprising a glass reinforced plastics material;

(B) Cutting out one or more cut outs from said panels to produce cut out waste comprising glass reinforced plastics material;

(C) Breaking the cut out waste into particulate glass reinforced plastics material (iii);

(D) Mixing the particulate glass reinforced plastics material (iii) with particulate cellulosic material (ii) to form a mixture (b);

(E) Mixing the mixture (b) with a portion (a) of plastics material; and

(F) Causing the plastics material (i), fibrous cellulosic material (ii) and glass-reinforced plastics material (iii) to solidify to form a cellulosic fibre-polymer composite product.

12. A method, according to any one of claims 8 to 11, wherein the mixture of (a) plastics material (i) and (b) particulate cellulosic material (ii) and glass-reinforced plastics material (iii) is heated, extruded through a die and then cooled to form an extruded product.

13. A method according to any one of claims 8 to 12, wherein (i) the plastics material, (ii) the particulate cellulosic material and (iii) the glass reinforced plastics material are recycled materials.

14. A method according to any one of claims 8 to 13, wherein the materials are provided in an amount of :

(a) less than 50% by weight of plastics material (i); and

(b) more than 50% by weight of the mixture of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii),

where the total of (a) and (b) adds up to 100%.

15. A method according to claims 8 to 14, wherein the glass reinforced plastics material (iii) is up to 30% by weight of the total weight of the mixture (b) of fibrous cellulosic material (ii) and glass-reinforced plastic material (iii).

16. A method according to any one of claims 8 to 15, wherein the glass reinforced plastic material comprises a thermoset plastics material reinforced with glass fibres.

17. A method according to any one of claims 8 to 16, wherein the glass reinforced plastics material comprises 5% to 50% of glass fibre.

18. A method according to any one of claims 8 to 19, wherein the glass reinforced plastics material comprises one of more components selected from: polyurethane foam, fillers, paint, pigments and fire retardants.

19. A cellulosic fibre polymer composite product comprising a composite material according to any one of claims 1 to 8 or obtainable by a method according to any one of claims 8 to 18.
20. A product according to claim 19 which comprises a rail, jamb, sill, track, stop sash or a trim element such as a skirting board, grid, cove or quarter ran, or at least a portion of a door frame.
21. A method of making a door comprising providing at least a portion of a doorframe as defined in claim 20 and sandwiching the doorframe between at least two panels, at least one of said panels comprising a glass-reinforced plastics skin.
22. A method of recycling a door, the door comprising a frame sandwiched between two or more panels, at least one of said panels comprising glass reinforced plastics material, said method comprising the steps of:
- (A) Breaking the door, including the frame and panels, into particulate glass reinforced plastics material (iii);
  - (B) Mixing the particulate glass reinforced plastics material (iii) with particulate cellulosic material (ii) to form a mixture (b);
  - (C) Mixing the mixture (b) with a portion (a) of plastics material; and
  - (D) Causing the plastics material (i), fibrous cellulosic material (ii) and glass-reinforced plastics material (iii) to solidify to form a cellulosic fibre-polymer composite product.
23. A method according to claim 22, wherein the ratio of particulate glass reinforced plastics material to particulate fibrous cellulosic used is approximately 1:1, weight : weight.

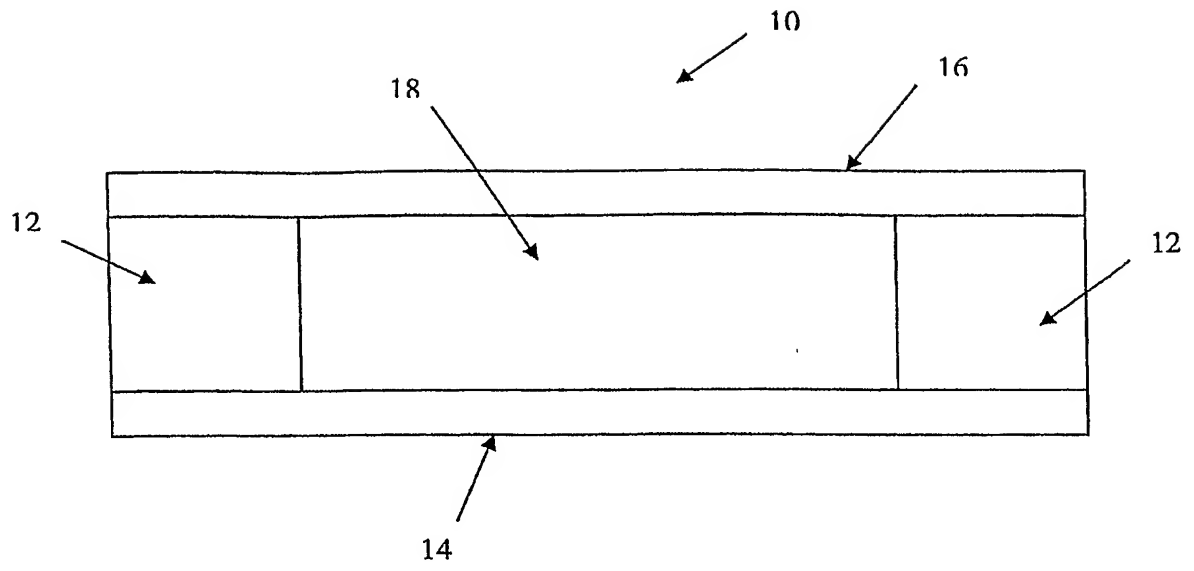


Figure 1

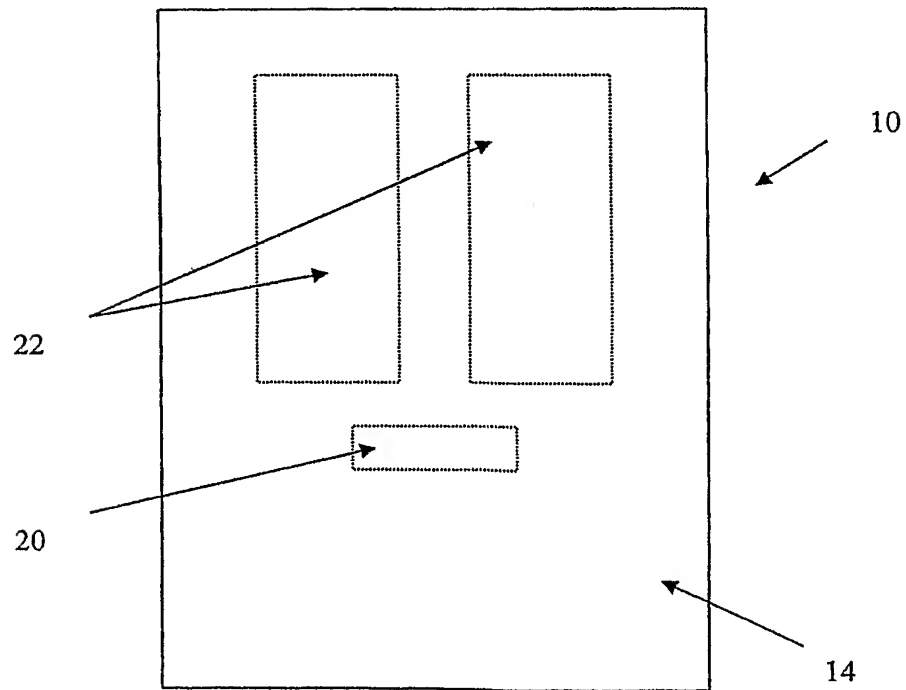
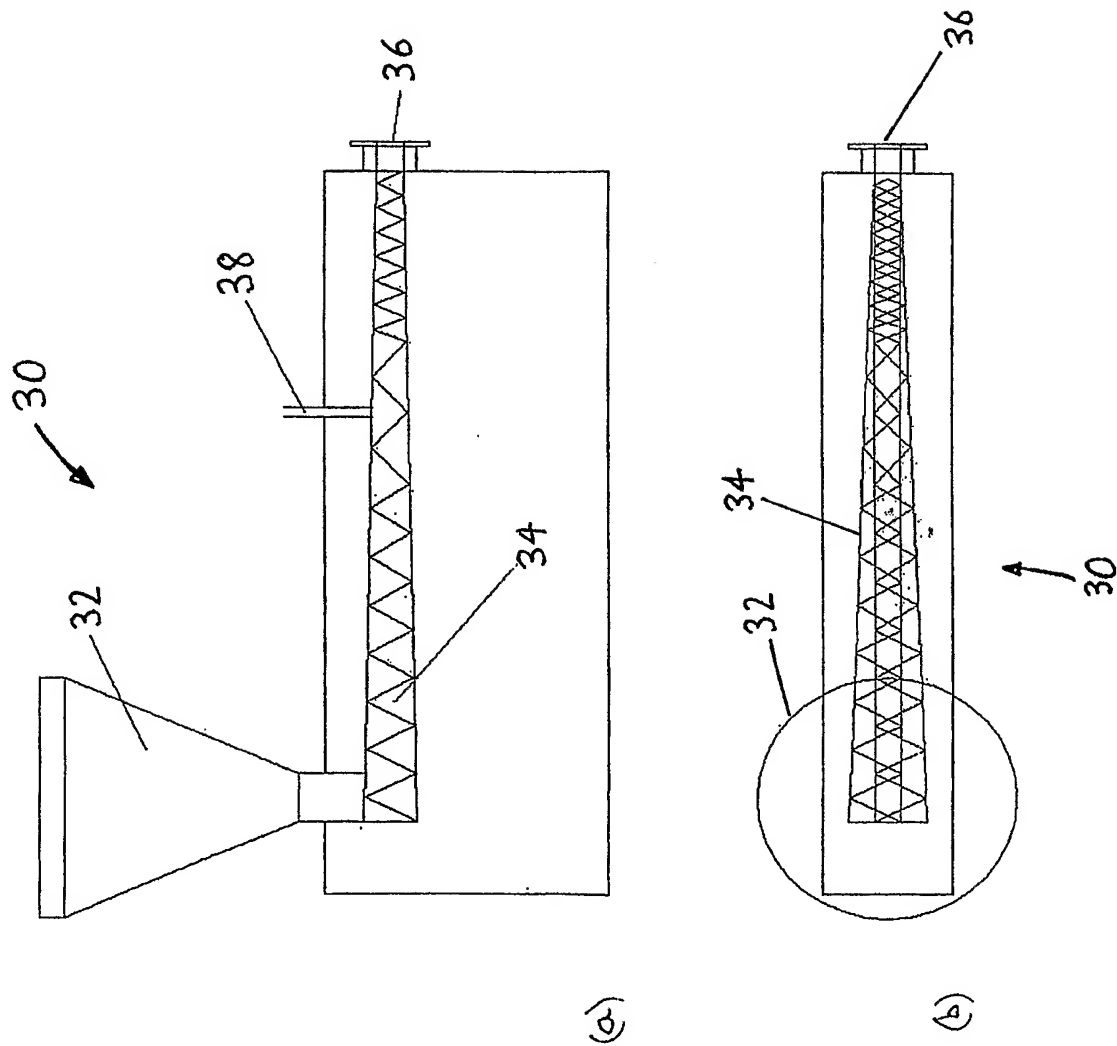


Figure 2

Figure 3



# INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2007/000257

## A. CLASSIFICATION OF SUBJECT MATTER

INV. C08L97/02 B29C47/00 C08J5/04 C08K7/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C08K C08J B29C E06B C08L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/025827 A (TIMBAPLUS PRODUCTS LTD [GB]; LLOYD KIM [GB]) 24 March 2005 (2005-03-24) cited in the application claims 24-42,70	1-23
X	US 6 106 944 A (HEIKKILA KURT E [US] ET AL) 22 August 2000 (2000-08-22) claims 1,5-12	1-23
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

19 April 2007

Date of mailing of the international search report

26/04/2007

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# INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2007/000257

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 539 027 A (DEANER MICHAEL J [US] ET AL) 23 July 1996 (1996-07-23) column 2, line 28 - line 35 -----	1-23

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Information on patent family members

International application No

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